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## METHOD AND APPARATUS FOR WIRELESS ROUTER MULTICAST

### BACKGROUND OF THE INVENTION

In a telecommunications network, it is often desirable to send the same message to a group of recipients. Methods are known for establishing a group of message recipients as a multicast group. Such a group of recipients share a common group address for receiving messages sent to the multicast group. A message designated as a multicast message can then be sent to all members of the multicast group by simply addressing the message to the group address.

Message transmission in a telecommunications network occurs over a variety of physical media. For example, a telecommunications network may include wireless communication networks. Wireless communication networks are notable because message transmission occurs over a wireless connection via a radio channel, rather than via a physically conductive, or wired connection which is common in a telecommunications network. In a typical wireless communication network, a base station processor is in communication with a plurality of subscriber access units (subscribers). The base station processor also maintains a wired connection to the telecommunications network. Each of the subscriber access units is connected to a plurality of user computing devices, such as user PCs. In this manner, a user computing device is provided a wireless connection to a telecommunications network through the subscriber access unit and the base station processor in wireless communication with the subscriber access unit.

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## SUMMARY OF THE INVENTION

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## BRIEF DESCRIPTION OF THE DRAWINGS

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Fig. 1 is a block diagram of a wireless communication system suitable for performing multicast message transmission as defined herein;



Fig. 4 shows the sequence of messages for establishing and transmitting to a multicast group.

A description of a preferred embodiment of the invention follows. Fig. 1 is a block diagram of a communication system 10 operable for multicast message transmission in a wireless network as defined herein. The communication system includes local computing devices, generally user PCs 12, subscriber access units 14, a base station processor 16, and an internetworking gateway 18. The user PCs 12 are in communication with the subscriber access units 14 via a wired connection 20. The subscriber access units 14 are in communication with a base station processor 16 via a wireless connection 26. The base station processor is in communication with an internetworking gateway 18 via a wired connection 24. The internetworking gateway 18 is adapted for communication via a public access network 28 such as the Internet.

Typically, the PC 12 provides a data packet, which may for example be an Internet Protocol (IP) packet, to the subscriber access unit 14 over the wired connection 20, which may for example be an Ethernet type connection. The subscriber access unit

14 removes the framing of the data packet and transfers the data in the data packet to the base station processor 16 over the wireless connection 26 in accordance with the wireless link protocol. The base station processor 16 extracts the wireless connection frames and forwards them, in data packet form, over the wired connection 24 to the  
5 internetworking gateway 18.

Similarly, packets sent from the public access network are sent to the base station processor 16 over the wired link 24, transmitted to the corresponding subscriber access unit 14 over the wireless link 26, and sent to the user PC 12 over the wired link 20. The subscriber access unit 14 and the base station processor 16 therefore denote  
10 endpoints of the wireless connection 26, providing a wireless link from the user PC 12 to the public access network 28 such as the Internet.

Fig. 2 shows a base station processor in communication with a plurality of subscriber access units and operable to perform multicast message transmission as defined herein. Multicast messages are typically transmitted according to a protocol  
15 such as the Internet Group Management Protocol (IGMP), as defined in Internet RFC 2236. The base station processor 16 is in communication with a plurality of subscriber access units 14a-14f over a wireless connection 26. The base station processor 16 has a plurality of wireless channels 22a-22j (channels) operable to perform wireless  
20 communication between the subscriber access units 14 and the base station processor 16. The wireless channels 22 generally are allocated by the base station processor 16 to the subscriber access units 14 for sending and receiving wireless messages. Typically, the base station processor rapidly allocates and deallocates channels 22 to accommodate channel requests for messages sent between the subscriber access units 14 and the base station processor 16.

25 Typical wireless systems employ a shared paging and access method, common to all subscriber access units 14, that is used to provide communication with subscriber access units 14 when no dedicated wireless traffic channels 22 are allocated to send and receive messages. In such a system, a common paging channel 32 is used to notify a subscriber access unit 14 that it is being allocated a traffic channel 22. Also in such a

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system, a common access channel 30 is used by a subscriber access unit 14 to request a traffic channel 22 from the base station processor 16. Once traffic channels 22 are allocated, and the subscriber access unit 14 has been notified, the waiting messages are then forwarded by the subscriber access units 14 to the PC 12 or to the base station processor 16, depending on message direction.

In the example shown, described further below, channel 22c is allocated to subscriber access unit 14d on connection ID C14. Channel 22a is allocated to subscriber access unit 14b on connection ID C5. There are no channels allocated to subscriber access unit 14e on connection ID C11. Channel 22f is allocated to the multicast group indicated as subscriber ID 15 on connection ID C23. Connection ID C23 refers to a multicast group containing member connection IDs C14 and C11 which correspond to subscriber access units 14d and 14e respectively. The multicast message is sent via channel 22f, providing both wireless connections 26a and 26b, and is received concurrently by subscriber access units 14d and 14e, respectively. In this manner, multiple redundant message transmissions, each entailing a separate channel allocation, are avoided.

Referring in more detail to Fig. 2, the base station processor 16 has a routing table 34, a connection table 36, and a multicast group table 38. The routing table associates a network address 40, indicative of a user PC 12 (Fig. 1) with a connection ID 42. The connection table 36 associates connections with channels. For each connection ID 42, a corresponding channel ID 46 is stored. The subscriber ID 44 for which a channel 22 is allocated is also stored. For connection IDs 42 corresponding to multicast groups, a separate connection table 36 entry is maintained for each multicast group. Note that since the channels 22 are allocated on a demand basis as messages are received, the connection table 36 entries corresponding to a connection ID may be added and deleted as messages arrive and are sent on, as will be discussed further below. The group management table 38 associates a multicast group address 40 with a connection ID 42 and a list of group member connection IDs 48. Each connection ID 42 from the connection table 36 that is included in the membership of the multicast group

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10 to receive, or listen, on the same channel 22.

14e respectively. In the example, connection ID 23 in column 42 is associated with subscriber access unit 15 in column 44. Subscriber access unit 15 is used as a designation of a multicast group user. This designation is exemplary and other suitable designations can be employed. As depicted in the connection table 36, connection ID C23 is allocated channel 22f. In the group management table 38, connection ID C23 is associated with group members having connection IDs C14 and C11. These two multicast connections are illustrated as wireless connections 26a and 26b, respectively.

both subscriber access unit 14d and 14e are receiving, or listening, on channel 22f.

Group establishment and the transmission of a multicast message will be described in more detail below.

Fig. 3 shows a flowchart depicting the sequence of multicast message transmission processing. Referring to Figs. 3 and 2, a message is received at the base station processor 16, as shown in step 100. A check is made to determine if the message is a multicast message, as depicted in step 102. If the message is not a multicast message, unicast transmission continues, as disclosed at step 104. If the message is a multicast message, a check is made to determine whether the message contains control information or data traffic, as depicted in step 106. Control information is indicative of new multicast groups and additions and deletions of group members. If the message contains control information, multicast group join/delete processing is performed, as shown at step 108. Otherwise, a lookup is performed in the routing table 34 to find the group address, as disclosed at step 110. The connection ID corresponding to the multicast group is retrieved, as shown at step 112. The connection ID corresponds to a group entry in the group management table 38. A channel 22 is scheduled to be used to transmit the message, as shown at step 114. For each connection ID corresponding to the group connection list in the group entry of the group management table 38, a lookup is performed to find an entry in the connection table 36, as disclosed at step 116. For each connection, the subscriber access unit corresponding to the connection is retrieved, as depicted at step 118. The channel 22 to be allocated to transmit the message is stored in the connection table 36, as indicated at step 120. The channel 22 and subscriber access unit 14 are then added to the paging message corresponding to the multicast message, as shown at step 122. A check is made to determine if all connection IDs corresponding to this multicast group have been processed, as shown at step 124. If there are more connection IDs corresponding to the group connection list 48 in the group entry in the group management table 38, control reverts to step 116 to process the additional connection IDs, as depicted at step 126. When all subscriber access units 14 corresponding to the multicast group have been implicated in the paging message, the paging message is sent, as disclosed at step 128.

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It should be noted that exemplary IGMP messages are described herein, and that other messages and protocols exist which are indicative of requests to create and delete multicast groups, and to join and remove members from the multicast groups. Such messages include, but are not limited to, group query, group member list, join host group, leave host group, and others. The system and methods described herein are illustrative of the notion that a wired line multicast group protocol, such as IGMP used in a TCP/IP network, can be employed in a base station processor to provide efficient multicast group transmission in a wireless network. Through examining the group management messages in the base station processor as defined herein, wireless

channels, wireless connections, and wireless interfaces can be employed in an optimal manner.

Those skilled in the art should readily appreciate that the programs defining the operations and methods defined herein are deliverable to a base station processor in many forms, including but not limited to a) information permanently stored on non-writeable storage media such as ROM devices, b) information alterable stored on writeable storage media such as floppy disks, magnetic tapes, CDs, RAM devices, and other magnetic and optical media, or c) information conveyed to a computer through communication media, for example using baseband signaling or broadband signaling techniques, as in an electronic network such as the Internet or telephone modem lines. The operations and methods may be implemented in a software executable out of a memory by a processor or as a set of instructions embedded in a carrier wave. Alternatively, the operations and methods may be embodied in whole or in part using hardware components, such as Application Specific Integrated Circuits (ASICs), state machines, controllers or other hardware components or devices, or a combination of hardware and software components.

While the system and method for transmitting multicast messages in a wireless communication network have been particularly shown and described with references to embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims. Accordingly, the present invention is not intended to be limited except by the following claims.